International Surgery Journal
Deskit P. Int Surg J. 2026 Aug;13(8):1354-1360
https://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: https://dx.doi.org/10.18203/2349-2902.isj20262454

Original Research Article

Gastrointestinal tract at high altitude of Ladakh: a surgeon's perspective

Padma Deskit*

Department of Surgery, SNM Hospital Leh, Ladakh, India

Received: 12 March 2026
Revised: 04 June 2026
Accepted: 10 July 2026

***Correspondence:**
Dr. Padma Deskit,
E-mail: drpadmadeskit@gmail.com

ABSTRACT

Background: High altitude environment with its hypoxic rarefied, cold, dry and high wind velocity affect almost all aspect of human physiology. However, attitude sickness is generally equated with HACE and HAPE. At high altitude, cellular hypoxia is found to have profound effect on the Gastrointestinal Tract (GI), which otherwise is mostly ignored. It is estimated that 80% of people who have acute mountain sickness have GI symptoms. The spectrum of GI dysfunctions which occur at high altitude are wide and varied but still not commonly talked about unlike HACE and HAPE.

Methods: The present study is a post-facto, retrospective in nature where observations and data are collected during April 2023 to April 2024, at SNM Hospital, Leh in Ladakh (UT) of India (the only government hospital in Leh), located at an altitude of 3000 meter AMSL. Data collected is based on the patients who had reported to emergency and OPD of SNM hospital with gastrointestinal ailments which are conventionally attributed to short and long term stay at high altitude. In addition, some unique conditions which has been managed by the author at different time frame are also reported in this study, because of they being rare, unique and challenging for a clinician and to further substantiate this study.

Results: This study unveiled some unique observations found in high altitude Ladakh region in gastrointestinal context, and some of which were: peptic ulcer perforation was more common than GI bleed. Of the 29 cases of peptic ulcer perforation operated, 19 were lowlanders (65.5%); GI bleed due to peptic ulcer was never seen in both the lowlanders and locals unlike the study from Tibet; carcinoma stomach is the most common malignancy in Ladakh, the figure of 54 number of patients in a year (2023) against the 1.3 Lakh total population of Leh district is comparable to the high incidence rate reported in Mizoram, the state with highest incidence of carcinoma stomach. This rate is definitely higher than the national average; four cases of mesenteric ischemia is reported which otherwise due to venous thrombosis is a rare occurrence and no report of high altitude induced mesenteric venous ischemia is available in literature. Similarly splenic abscess was also seen in some of the tourist visiting Ladakh.

Conclusions: High altitude related conditions are needed to be seen and understood through a wider lens and not just HACE and HAPE. Understanding and sharing of experience of high-altitude related condition is essential for further understanding of the topic under discussion. Keeping in view the wide spectrum of gastrointestinal dysfunction occurring in both local and visitor there is need to talk about it on equal footing like HACE and HAPE.

Keywords: HACE, HAPE, High altitude, GI dysfunction and cellular hypoxia, Ladakh

INTRODUCTION

Visit to high-altitude places can result in many medical conditions called mountain sickness. Mountain sickness can be acute or chronic depending upon the time of presentation of symptoms after arrival at a high altitude.[1] Since the hypoxic rarefied air affects the entire human physiology and function, so altitude sickness is not only

confined to the respiratory system and the nervous system, as popularized by the high-altitude cerebral edema and high altitude pulmonary edema.

In addition to the High-Altitude Cerebral Edeme (HACE) and High-Altitude Pulmonary Edema (HAPE), the hypoxia affects the vascular system, and gastrointestinal system equally.[2] The gastrointestinal symptoms of high altitude can range from mild dyspepsia to life threatening conditions like mesenteric ischemia, duodenal ulcer perforation to even gastric malignancies. The appearance of these more serious GI symptoms are however not prompt and acute. They are seen if a person stays at high altitude beyond fortnight.

Gastrointestinal tract affliction at high altitude can be explained by cellular hypoxia, coupled with splanchnic vasoconstriction in response to altitude induced increased sympathetic tone leading to gastrointestinal tract mucosal ischemia.[3,4] This can be aggravated by dehydration, and muscular activities. If hypoxia and ischemia persist, there occur a cascade of inflammatory and oxidative stress leading to various conditions ranging from leaky gut with altered microbiome which manifest as bloating and dyspepsia, to peptic ulcer disease and its complication.[5-8] Coupled with the above conditions increased prevalence of *Helicobacter Pylori* infection (99% prevalence in local population) and increased virulence of Cag G antigen in *H. pylori* isolated from locals, the hypergastrinemia secondary to hypoxia induced decreased production of hydrochloric acid by the parietal cells, and absence of antioxidants like fresh fruits and vegetable during cold winter months could be the reason for increased incidence of duodenal and gastric ulcer and its complication like perforation and bleeding and even gastric malignancy in the region.[9-14] Even in the Ladakh region wide disparity in the incident rate is seen with local Buddhist population showing more case as compared to Muslim (as the two have different ethnic origin).

Some locals and prolonged visitors develop increased vagal tone in response to hypoxia leading to prolonged transit time which in turn lead to constipation and related issues and increased incidence of gallbladder stone compared to global incidence of gall stone disease.[8,17,18]

Thrombogenic effect at high altitude could be explained by hypoxia induced increased blood viscosity, reduced fibrinolytic activity, procoagulant state and inflammatory activation of endothelium.[19,20] Thrombosis is seen in both arterial and venous system.[21-23] The condition manifest clinically as deep venous thrombosis and pulmonary embolism, life threatening mesenteric venous ischemia and splenic infarct.[24,25] Also rarely volvulus could be seen in lowlander if they ascend rapidly.[26]

The author working as a surgeon in high altitude for more than two decades (with little or no learning's of high altitude during medical school or while working in hospitals in the lowlands of India), the learning experience gathered in high altitude, helped the author to understand high altitude maladies in other perspective also, apart from just HACE and HAPE.

In this context, the objective of this study is to highlight the GI surgical conditions which are proposed or are conventionally attributed to high altitude, so that awareness is created among the clinician, researchers and people visiting and living in high altitude. The study is probably the first write up by a surgeon working in high altitude region about surgical issues arising due to high altitude.

METHODS

The present study is a post-facto, retrospective in nature where observations and data are collected during April 2023 to April 2024, at SNM Hospital, Leh in Ladakh (UT) of India (the only government hospital in Leh), located at an altitude of 3000 meter AMSL. The subjects were self selected in nature as the data collected are based on the patients who had reported (self-selection) to emergency and OPD of SNM hospital with gastrointestinal ailments which are conventionally attributed to short and long term stay at high altitude. As required by the nature of study, simple arithmetic mean average and percentage values were used to make the study lucid and easily comprehensible. In addition to it, some unique cases related to the subject domain of this study and which has been managed by the author at different time frame are also reported in this study, because of they being rare, unique and challenging for a clinician and to further substantiate this study.

RESULTS

The results found in this study is presented in the form of observations, and illustrated below:

Gastrointestinal upset

GI upset is a universal symptom in local and visitor alike. In order to remove the confounding factors for GI upset two days random survey was carried out in the tourist OPD of SNM hospital catering exclusively to the tourists visiting Ladakh during the peak tourist season. Most of the patients come to this OPD with altitude associated symptoms. 84% of patient complaints of GI upset in the form of nausea, vomiting, anorexia, flatulence etc. This was either isolated or in addition to symptoms of headache and breathlessness.

Incidence of peritonitis due to peptic ulcer perforation in SNM hospital Leh

Peptic ulcer perforation is a common cause of peritonitis. Unlike in rest of world the incidence of peptic ulcer perforations are seen commonly in Leh especially among the incoming seasonal labour from low altitude states like

Bihar or Madhya Pradesh etc. Also noteworthy is the location of perforation which is seen mostly in antropyloric region unlike in other places where it is seen in the first part of duodenum. Details provided in Table 1.

Table 1: Incidence of peritonitis due to peptic ulcer perforation in SNM hospital Leh.

Details of patient	Number
No of patients from low altitude	19
No of patients from Ladakh	10
Total No of cases	29
Site of perforation	
Corpus	0
Antropyloric region	26
Duodenum (D1	2
No perforation due to malignancy	1

Incidence and distribution pattern of carcinoma stomach in Ladakh

Carcinoma Stomach in Ladakh account for maximum number of cancer cases recorded. Unlike in the developed world the cancer primarily affects the distal stomach and due to the silent nature of disease progression and remoteness of the region patient present very late with dismal outcome. Details provided in Table 2.

Table 2: Incidence and pattern of carcinoma stomach in Ladakh.

Total number of cancer cases registered under NCD in SNM hospital	156 Nos
Total number of carcinoma stomach cases	54 Nos (M 40 + F 14)
Distribution of patient as per the anatomical location of malignancy in the stomach	
Gastroesophageal junction	3
Fundus	Nil
Body	2
Distal body (pyloric and antrum)	49
Stage of disease at the time of presentation	
Stage I	Nil
Stage II	2
Stage III	37
Stage IV	15

Cholelithiasis in Leh Ladakh

Cholecystectomy is the most common surgery performed among the elective cases operated in the SNM hospital Leh. In the year 2023, out of total 506 numbers of Cholelithiasis in Leh, number of major surgeries done were 317 and cholecystectomy done were 189 in numbers.

Figure 1: Cect finding showing presence of free air in the peritoneal cavity and air entrapped in the intestinal wall as air filled cyst and bullae.

Figure 2: A) Laparotomy finding showing gangrenous ileu.m and pinky and shiny jejunum in a case of mesenteric ischemia, B) Resected specimen of ileum and jejunum.

Figure 3: Operative specimen of Spleen with area of suppuration and rupture of three week old splenic infarct.

Mesenteric ischemia due to venous thrombosis

Though very little is written about mesenteric ischemia and high altitude. Our experience of dealing with four cases of mesenteric venous ischemia [two numbers of army men serving at extreme high altitude (no known comorbidity); and two civilian persons comprising of a nun living in high altitude Changthang valley (post traumatic gibbus), and the other one a farmer from Leh valley (hypertensive)] saw equal distribution among the lowlanders as well as the native. The army men were evacuated to higher centre after primary surgery and on

follow up they were sent abroad for further treatment. The nun was operated, and she is still on follow up. She is facing nutritional issue including vitamin deficiency.

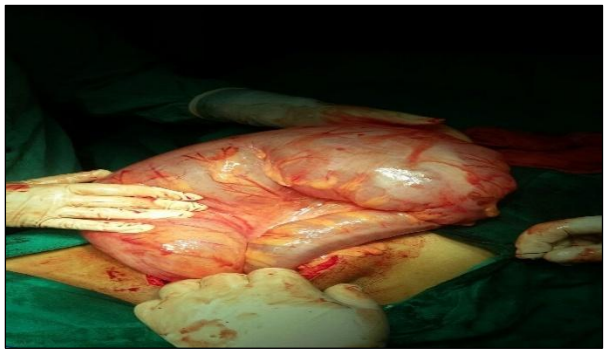

Figure 4: Extreme gaseous dilatation of sigmoid colon in a 16 years old girl due to volvulus.

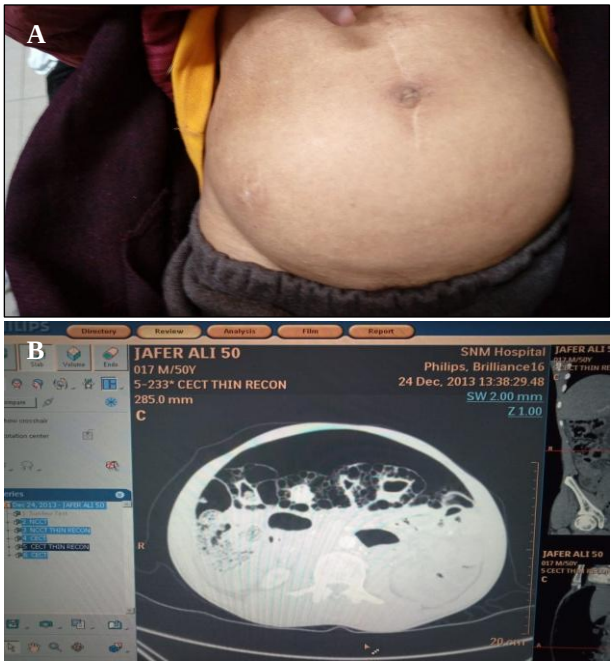

Figure 5: A) Pneumotosis intestinalis: Gross distension of gaseous distension of abdomen due to free air arising due to rupture of air filled bulla, B) CT Abdomen finding of pneumoperitoneum and air filled cyst and bullae in the intestinal wall

DISCUSSION

Symptoms of GI upset though are cardinal feature of high altitude associated maladies but are not given due importance by patients and general physician alike due to lack of awareness even in hospitals. Thus, general people visiting Ladakh need to be made aware about this symptom especially among children in whom GI symptom may be the only presentation.

Dyspepsia is a very common complaint in visitors and local of high altitude including our patient at SNM hospital Leh. This is attributed to higher incidence of peptic ulcer disease as discussed already. It can lead to peptic ulcer perforation or upper GI bleed. As reported by Pawar et al from Nubra region of Ladakh, peptic ulcer perforation was more common than GI bleed in SNM hospital as well.[15,16] Of 29 cases of peptic ulcer perforation operated at Leh 19 were lowlanders (65.5%) and the rest were local. (Table 1, Figure 1). Of these lowlanders, all were from low socioeconomic strata (seasonal labours). In contrast to the locals all of whom give history of chronic dyspepsia and epigastric pain, the visitors however had no history of longstanding dyspepsia.[14] Tobacco consumption in all form was present in all 29 cases. GI bleed due to peptic ulcer was never seen in both the low landers and locals unlike the study from Tibet.[15] None of patients had associated polycythaemia unlike the patient of gastric ulcer in Tibet.[27] Most of patients in both groups the perforation was most commonly seen in distal part of stomach (anthropologic region) unlike in other developing countries where perforation occur in D1.[16]

Carcinoma stomach is the most common malignancy in Ladakh (Table 2). In absence of any form of cancer registry in Ladakh, the data gathered is from SNM hospital NCD OPD registry. In the calendar year 2023, there is 54 histopathologically proven patients of carcinoma stomach, registered at SNM hospital. There are high chances that this number would be more as many patients who go out of Leh for oncological consultation do not report to SNM hospital as no super speciality care is available in SNM hospital. This figure of 54 patient in a year for the total population of Leh district of 1.3 lakh is comparable to the high incidence rate seen in Mizoram, the state with highest incidence of carcinoma stomach.[28] This rate is definitely higher than the national average. The AAR of gastric cancer among the urban registries in India is 3.0-13.2.[29,30] The AAR of carcinoma stomach in Mizoram is 50.6 in male and 23.3 in female.[28] Like high incident region of Mizoram and Kashmir, Ladakh do have some high-risk dietary behaviour like high salt intake in the form of local salted butter tea and lack of fresh fruit and vegetables in the daily diets, increased usage of chung (local fermented beer) etc.[28,30] However, in recent time the intake of salted tea has decreased and vegetable intake increased considerably due to improved connectivity, but the incidence of carcinoma stomach is steadily increasing. So genetic susceptibility and virulent strain of *H. pylori* stand out to be the main possible culprit. Genetic susceptibility and tumour biology and the reported highly virulent prevalent strain of *H. pylori* in Ladakh need to be understood in depth as there is wide variation in the geographical distribution of disease.

Regions of Turtuk and Bogdang see very low incidence of cancer in general and carcinoma stomach in particular with only one case of carcinoma stomach reported from this region in past three years. Incidence is also relatively less in Muslim population as compared to Buddhist. This could possibly be explained by the fact that people from

low incident area trace their lineage to the region of Baltistan, similar to the resident of Hunza in Pakistan and region is relatively at lower altitude with higher production of fruits like apricot, apple etc. The ethnicity of population may also contribute to be the cause for increased predisposition for cancer in general and cancer of stomach in particular among the Buddhist population, as their ancestors are believed to be Tibetan origin while the Muslim population from Kashmir.

All cases are adenocarcinoma of distal stomach like in the rest of developing countries with high *H. pylori* burden.

Lack of awareness among the masses coupled with strained health facility especially availability of endoscopy could be the reason of delayed presentation, with one patient presenting as peritonitis due to tumour perforation. Most cases are diagnosed in late stages (stage iii and iv) with dismal five years survival rate.

Mesenteric ischemia (Figure 2a and 2b) due to venous thrombosis is a rare occurrence. Till now, no report of high altitude induced mesenteric venous ischemia could be found in the literature. The author has managed four such cases. Of the four cases managed as mesenteric venous ischemia, two were locals and two army men posted in Siachen (Figure 2A and 2B). one army men were posted at high altitude after completing the induction period and developed symptoms insidiously over period of week. The condition started solely as nonspecific gastrointestinal symptoms like colic, anorexia and nausea which progressed into bloody diarrhoea, peritonitis and hypovolemic shock over period of five to six days. No co morbidities were seen in both of them. Among locals one was a 56-year-old nun residing in extreme high-altitude region of Changthang with history of traumatic fracture of spine in childhood and another one was a male with no definite risk factors were identified except hypertension. Their presentation was similar to the nonlocals. Except leucocytosis and raised haematocrit and raised blood urea nitrogen no other biochemical abnormality was noted. All four of them underwent massive small gut resection. Three out of four patients survived after undergoing massive small gut resection. Damage control surgery was done consisting of resection of ileum expect the distal 10-15 cm and distal jejunum (the distal one third) in all the cases. Unfortunately for us we did not had facility of doing advanced coagulation profile except platelet count which was normal in all.

Splenic abscess was also seen in some of the tourist visiting Ladakh. It proposed association with sickle cell trait could be studied due to lack of facility at SNM hospital to test for sickling. Those patients who were evacuated immediately have a favourable outcome. Inability to do so could lead to complication like splenic abscess and rupture (Figure 3). The author has also managed a case of high altitude induced testicular infarct and thrombosis in the dorsal vein of penis.[25]

Unlike the high-altitude region of Andes which sees a huge burden of high altitude induced volvulus, we do not see volvulus regularly, except one peculiar case of sudden onset of volvulus in young girl who rapidly ascended from sea level to a place at altitude of 5360 metre over sea level. Such occurrence could be explained on the basis of rapid expansion of intestinal gases in accordance with the Laplace law and Boyle law (Figure 4).

One condition which need special mention is the occurrence of pneumatosis intestinalis in three patients from high altitude region of Ladakh (Figure 5a and 5b). These, patient posed a diagnostic dilemma due to extreme distension with no evidence of obstruction or peritonitis but free air on CT scan of abdomen. This patient also had no feature of septicaemia or intestinal gangrene. Presence of free air entrapped in the wall of small intestine help to clinched the diagnosis. All the cases were managed conservatively with supportive treatment including high flow oxygen. In one case, a patient due to extreme discomfort due to distension, a drain was placed.

CONCLUSION

High altitude related conditions are needed to be seen and understood through a wider lens and not just HACE and HAPE. Understanding and sharing of experience of high-altitude related condition is essential as nature is the greatest Laboratory which cannot be fully comprehended in a single shot. Difficulty in creating a simulated hypoxic hypobaric environment poses additional challenge. Keeping in view the wide spectrum of gastrointestinal dysfunction occurring in both local and visitor, there is need to talk about it on equal footing like HACE and HAPE.

Recommendations

Based on the findings of this study, the establishment of hospital- and population-based cancer registries is recommended to accurately assess the burden of gastric cancer in Ladakh. Public awareness programs should promote healthy dietary habits, early recognition of symptoms, and timely medical consultation. Screening with upper gastrointestinal endoscopy, particularly among individuals above 50 years of age, should be strengthened to facilitate early detection.

Given the high prevalence of *Helicobacter pylori* infection, population-based screening and eradication programs should be implemented, especially for individuals above 30 years. Strengthening local healthcare capacity through advanced training of physicians and surgeons in oncology care, supported by tertiary centers, is also essential. Further research into the

molecular basis of gastric cancer, particularly among the Buddhist population, is warranted.

Mass awareness campaigns, endoscopy screening camps, regulation of over-the-counter proton pump inhibitor use, and education on high-altitude-related health risks should be prioritized to improve prevention, early diagnosis, and management of gastric cancer in this region.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Hackett PH, Oelz O. The Lake Loiuse Consensus on the definition and quantification of altitude illness. In: Hypoxia and Mountain Medicine. Sutton JR. Coates G. Houston CS, eds. Pergamon Press, Oxford, UK; 1991:327-330.
2. Roach RC, Hackett PH, Oelz O, Bärtsch P, Luks AM, MacInnis MJ, et al. Lake Louise acute mountain sickness score. High Alt Med Biol. 2018;19(1):4-6.
3. Anand AC, Sashindran VK, Mohan L. Gastrointestinal problems at high altitude. Trop Gastroenterol. 2006;27(4):147.
4. Hainsworth R, Drinkhill MJ, Rivera-Chira M. The autonomic nervous system at high altitude. Clin Auton Res. 2007;17(1):13-9.
5. McKenna ZJ, Gorini Pereira F, Gillum TL, Amorim FT, Deyhle MR, Mermier CM. High-altitude exposures and intestinal barrier dysfunction. Am J Physiol-Regulat Integrat Comparat Physiol. 2022;322(3):R192-203.
6. Liu D, Chen D, Xiao J, Wang W, Zhang LJ, Peng H, et al. High-altitude-induced alterations in intestinal microbiota. Front Microbiol. 2024;15:1369627.
7. Khanna K, Mishra KP, Ganju L, Kumar B, Singh SB. High-altitude-induced alterations in gut-immune axis: a review. Int Revi Immunol. 2018;37(2):119-26.
8. Yoshimoto M, Sasaki M, Naraki N, Mohri M, Miki K. Regulation of gastric motility at simulated high altitude in conscious rats. J Appl Physiol. 2004;97(2):599-604.
9. Romero-Gallo J, Pérez-Pérez GI, Novick RP, Kamath P, Norbu T, Blaser MJ. Responses of endoscopy patients in Ladakh, India, to Helicobacter pylori whole-cell and CagA antigens. Clin Vacc Immunol. 2002;9(6):1313-7.
10. Sharma PK, Suri TM, Venigalla PM, Garg SK, Mohammad G, Das P, et al. Atrophic gastritis with high prevalence of Helicobacter pylori is a predominant feature in patients with dyspepsia in a high altitude area. Trop Gastroenterol. 2014;35(4):246-51.
11. Farinati F, Cardin R, Cassaro M, Bortolami M, Nitti D, Tieppo C, et al. Helicobacter pylori, inflammation, oxidative damage and gastric cancer: a morphological, biological and molecular pathway. Euro J Can Prevent. 2008;17(3):195-200.
12. Butcher LD, den Hartog G, Ernst PB, Crowe SE. Oxidative stress resulting from Helicobacter pylori infection contributes to gastric carcinogenesis. Cellu Mole Gastroenterol Hepatol. 2017;3(3):316-22.
13. Wroblewski LE, Peek Jr RM, Wilson KT. Helicobacter pylori and gastric cancer: factors that modulate disease risk. Clin Microbiol Revi. 2010;23(4):713-39.
14. Jó N, Garcia O, Jara R, Garmendia F, Nago A, Garcia R, et al. Serum gastrin and gastric acid secretion at high altitude. Horm Metabol Res. 1987;19(04):182-3.
15. Wu TY, Ding SQ, Liu JL, Jia JH, Dai RC, Zhu DC, et al. High-altitude gastrointestinal bleeding: an observation in Qinghai-Tibetan railroad construction workers on Mountain Tanggula. WJG. 2007;13(5):774.
16. Pawar A, Sinha V, Sharma P, Sinha DK. High altitude area–A risk factor for gastric perforation?: A case series. Int J Surg Case Rep. 2018;53:429-32.
17. Wang X, Yu W, Jiang G, Li H, Li S, Xie L, et al. Global epidemiology of gallstones in the 21st century: a systematic review and meta-analysis. Clin Gastroenterol Hepatol. 2024;22(8):1586-95.
18. Norboo T, Saiyed HN, Angchuk PT, Tsering P, Angchuk ST, Phuntsog ST, et al. Mini review of high altitude health problems in Ladakh. Biomed Pharmacother. 2004;58(4):220-5.
19. Wojta J. High altitude thrombosis-evidence for underlying mechanisms from a large prospective longitudinal study. The Lancet Regional Health-Southeast Asia. 2022;3:100039.
20. Prabhakar A, Chatterjee T, Bajaj N, Tyagi T, Sahu A, Gupta N, et al. Venous thrombosis at altitude presents with distinct biochemical profiles: a comparative study from the Himalayas to the plains. Blood Advan. 2019;3(22):3713-23.
21. Gupta N, Ashraf MZ. Exposure to high altitude: a risk factor for venous thromboembolism? Semin Thromb Hemost. 2012;38(2):156-63.
22. Gambhir RP, Anand V, Khatana SS, Bedi VS. A brief review of high altitude thrombosis. Ind J Vascu Endovas Surg. 2014;1(1):20-3.
23. Deskit P, Badwal M, Wangchuk PT. High altitude–induced testicular infarct: a rare occupational hazard. Ind J Surg. 2022;84(6):1325-7.
24. Al-Shraim MM, Zafer MH, Rahman GA. Acute occlusive mesenteric ischemia in high altitude of southwestern region of Saudi Arabia. Ann Afr Med. 2012;11(1):5-10.
25. Gonzalez L, Shapiro AF, Tafur A, Plaza-Meneses C, Sabando B. Splenic infarct secondary to high altitude exposure in sickle cell trait patients: A case series. Cureus. 2020;12(8):e9815.
26. Asbun HJ, Castellanos H, Balderrama B, Ochoa J, Arismendi R, Teran H, et al. Sigmoid volvulus in

the high altitude of the Andes: review of 230 cases. Dis Colon Rect. 1992;35(4):350-3.
27. Li K, He C. Gastric mucosal lesions in tibetans with high-altitude polycythemia show increased HIF-1A expression and ROS production. BioMed Res Int. 2019;2019(1):6317015.
28. Phukan RK, Narain K, Zomawia E, Hazarika NC, Mahanta J. Dietary habits and stomach cancer in Mizoram, India. J Gastroenterol. 2006;41(5):418-24.
29. Pavithran K, Doval DC, Pandey KK. Gastric cancer in India. Gastric Cancer. 2002;5(4):240.
30. Dikshit RP, Mathur G, Mhatre S, Yeole BB. Epidemiological review of gastric cancer in India. Ind J Medi Paediatr Oncol. 2011;32(01):3-11.

Cite this article as: Deskit P. Gastrointestinal tract at high altitude of Ladakh: a surgeon's perspective. Int Surg J 2026;13:1354-60.